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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Characterizing the Hydrologic Cycle with AIRS and Other A-Train Data Sets

Eric Fetzer (with Thanks to Many Colleagues)

Jet Propulsion Laboratory, California Institute of Technology

AIRS Science Team Meeting, Pasadena, CA

27 March 2007

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First came the proposal...

My idea (sort of)

With help from

Title

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PROPOSAL COVER PAGE

(Date : Dec 10, 2004)

NEWS/04-2-0000-0615

Name of Submitting Institution: Jet Propulsion Laboratory **Congressional District:** 26

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[3] ... Proposal Title (Short and/or Full)

Short Title:	A Merged Atmospheric Water Data Set
Full Title:	A Merged Atmospheric Water Data Set from the A-Train

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Our Proposed Work

- ***A combined atmospheric water data set from the A-Train.***
  - ***Includes:***
    - ***Temperature*** from AIRS.
    - ***Water vapor*** from AIRS, MLS, AMSR-E and MODIS.
    - ***Cloud top properties*** from MLS, AIRS, MODIS and CloudSat/Calypso.
    - ***Cloud liquid quantities*** from AMSR-E, MODIS and CloudSat.
    - ***Cloud ice quantities*** from MLS, CloudSat and AMSU-B on NOAA 16
- **Our data set:**
  - ***Preserves instantaneous relationships between observations along the orbit track.***
  - ***On a common, nested grid (inspired by 0.25 deg AMSR-E grid).***
- **Apply to MJO studies.**

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Programmatics

- **Our work is supported by the NASA Energy and Water-cycle Study (NEWS) program.**
  - ***See www.nasa-news.org***
  - ***Collaborative research between data providers, modelers and data analysts.***

- **Paraphrasing NEWS goals:**
  - ***The ultimate goal of NEWS is a breakthrough improvement in the nation's energy and water cycle prediction capability.***

  - ***Prediction systems...to quantify the hydrologic consequences of climate change and produce useful seasonal and longer-range hydrologic predictions...based on observed initial values and changing boundary conditions.***

- ***AIRS data are recognized as critical to these goals.***

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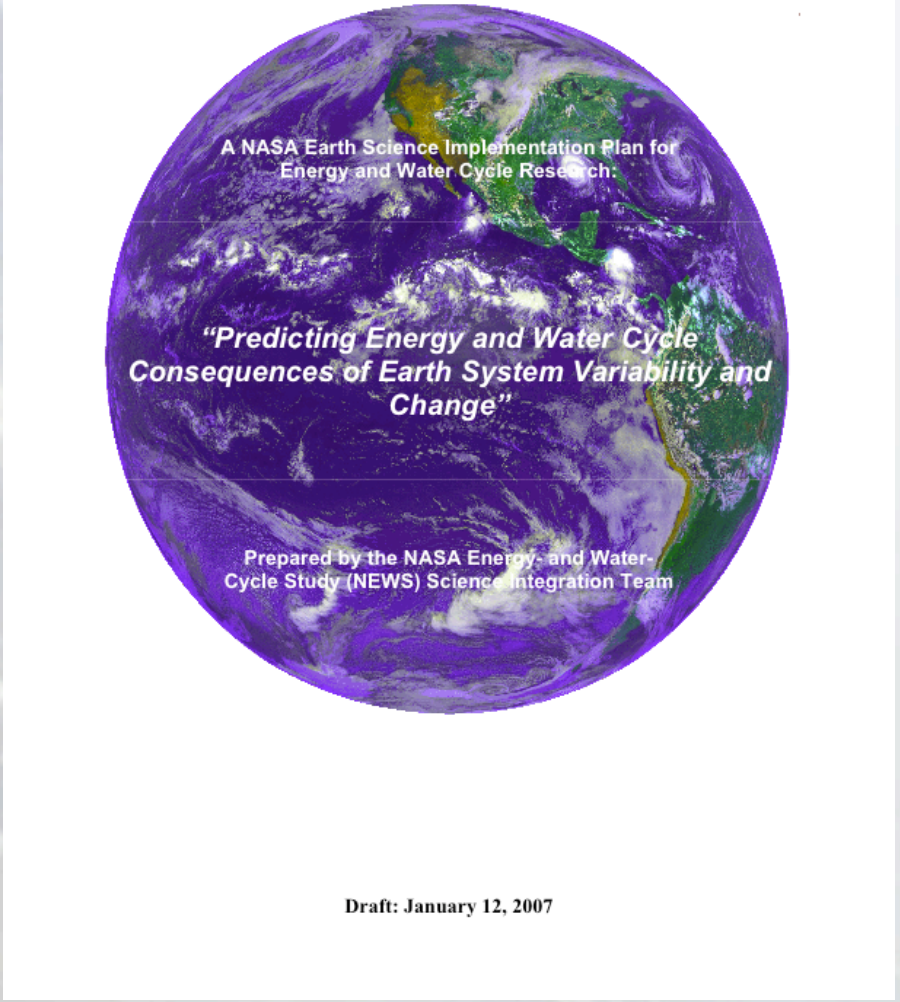
The NEWS Implementation Plan

Science and Programmatic Plans

- A shorter executive summary; essentially the NASA policy on improving hydrologic forecasts.
- More details in most of the 89 pages.



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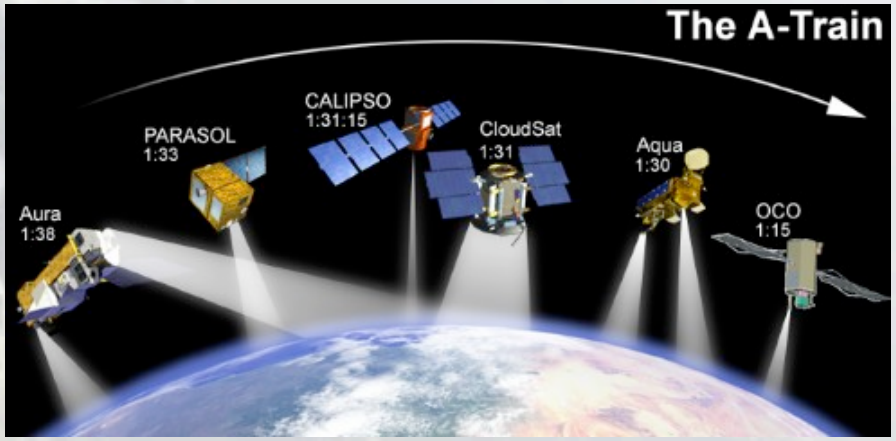
An A-Train Bestiary

- ***The A-Train*: formation-flying NASA satellites at 130 LT.**
- ***Several instruments measure atmospheric water substance*:**
  - ***Aqua:***
    - **AIRS** (Atmospheric Infrared Sounder)
    - **AMSR-E** (Advances Scanning Microwave Radiometer for EOS)
    - **MODIS** (Moderate Resolution Imaging Spectroradiometer)
  - ***Aura:***
    - **EOS MLS** (Microwave Limb Sounder)
  - ***CloudSat/Calypso***
    - CloudSat radar
    - Calypso lidar
  - ***Others:***
    - **CERES, TES, AMSU-B**.



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Some of Our NEWS Activity

- **Intercomparison of like quantities from different sensors.**
- **Creation of integrated data sets.**
- **MJO studies.**
- **Participation in NEWS research activities.**

Many of these task are directly relevant to AIRS science team activities.

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From: The Second GEWEX Cloud System Study Science and Implementation Plan, 2000

"To bridge the gap between what the data-collection community provides and what the modeling community needs, the task of *data integration* is absolutely essential. Unfortunately, it is always in danger of being ignored. Data integration consists of bringing together data from disparate instruments, and combining these data into a coherent physical description of what was observed, in a form suitable for use in the evaluation of the relevant models."

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A-Train Intercomparison Studies

Water Vapor:

Fetzer et al. (2006), Biases in total precipitable water vapor climatologies from Atmospheric Infrared Sounder and Advanced Microwave Scanning Radiometer, *J. Geophys. Res., 111*, D09S16, doi:10.1029/2005JD006598.

Fetzer et al. (2007), Global comparisons of upper tropospheric water vapor observations from the Microwave Limb Sounder and Atmospheric Infrared Sounder satellite instruments, *J. Geophys. Res.*, in preparation.

Garay et al. (2007), Comparison of AIRS and MODIS total water vapor, in preparation.

Clouds:

de la Torre Juarez et al. (2007), Comparison of MODIS and AMSR-E cloud liquid water, in preparation.

Kahn et al. (2007), Towards the characterization of upper tropospheric clouds using AIRS and MLS observations, *J. Geophys. Res., 112*, D05202, doi:10.1029/2006JD007336.

Kahn et al. (2007): The radiative consistency of AIRS and MODIS cloud retrievals, *J. Geophys. Res.*, in press.

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MJO Studies

Tian, B., D. E. Waliser and E. J. Fetzer, (2006), Modulation of diurnal cycle of tropical deep convective clouds by the MJO, *Geophys. Res. Lett.*, *30*, L20704, 10.1029/2006GL027752.

Tian, B., D. E. Waliser, E. J. Fetzer, B. H. Lambrigtsen, Y. L. Yung and B. Wang, (2006), Vertical moist thermodynamic structure and spatial-temporal evolution of the Madden-Julian oscillation in Atmospheric Infrared Sounder observations, *J. Atmos. Sci.*, *63*, 2462-2485.

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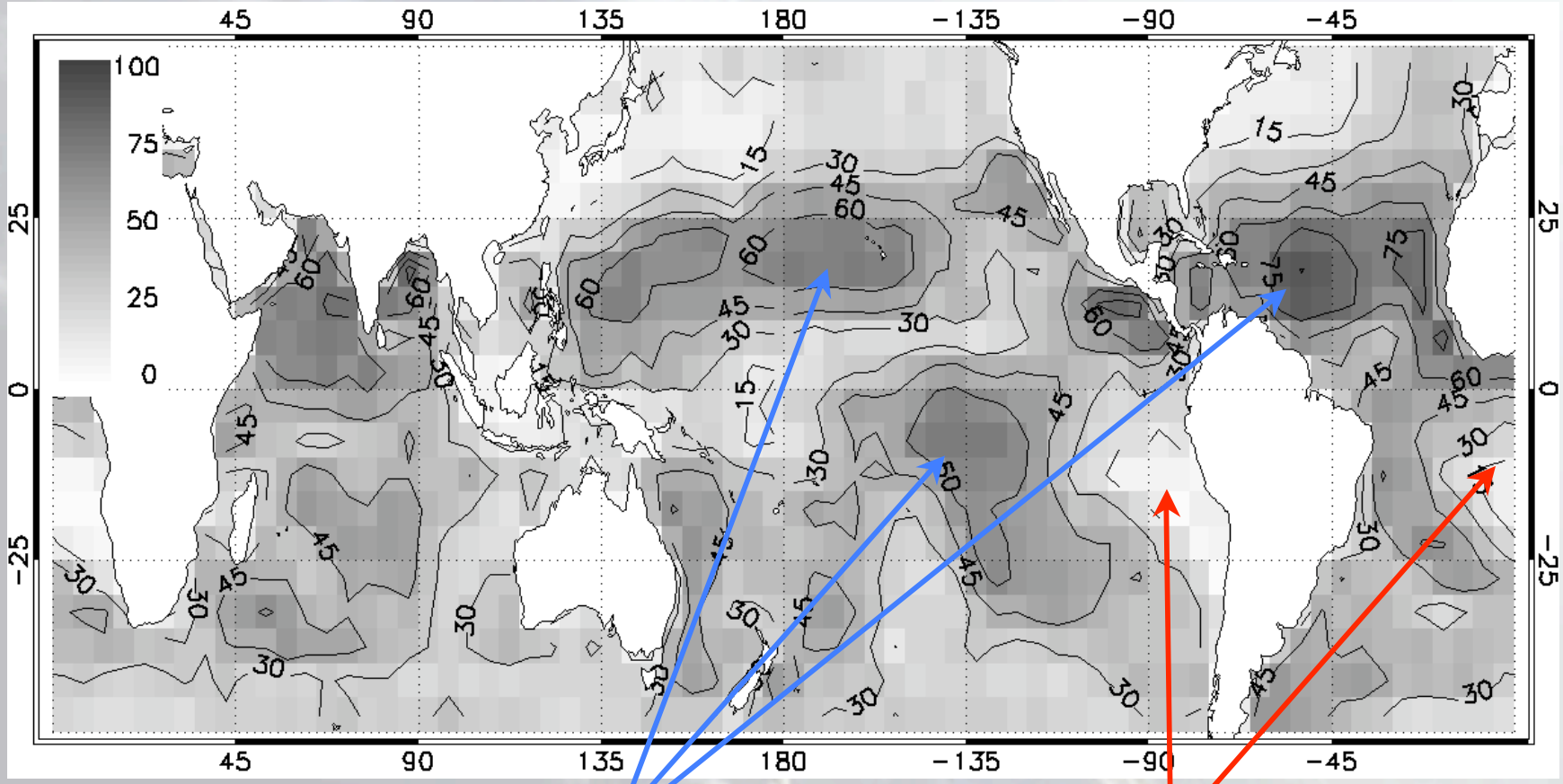
AIRS-AMSR-E comparison (Fetzer et al. 2006): AIRS retrieval yields vary with location

Fraction of 'good' retrievals (percent)

25 Dec 2002 to 15 Jan 2003



Highest yields in trade cumulus.
Good news for Fetzer et al. 2004.
Possible RICO study?

Poorer coverage of stratocumulus; use with caution here.

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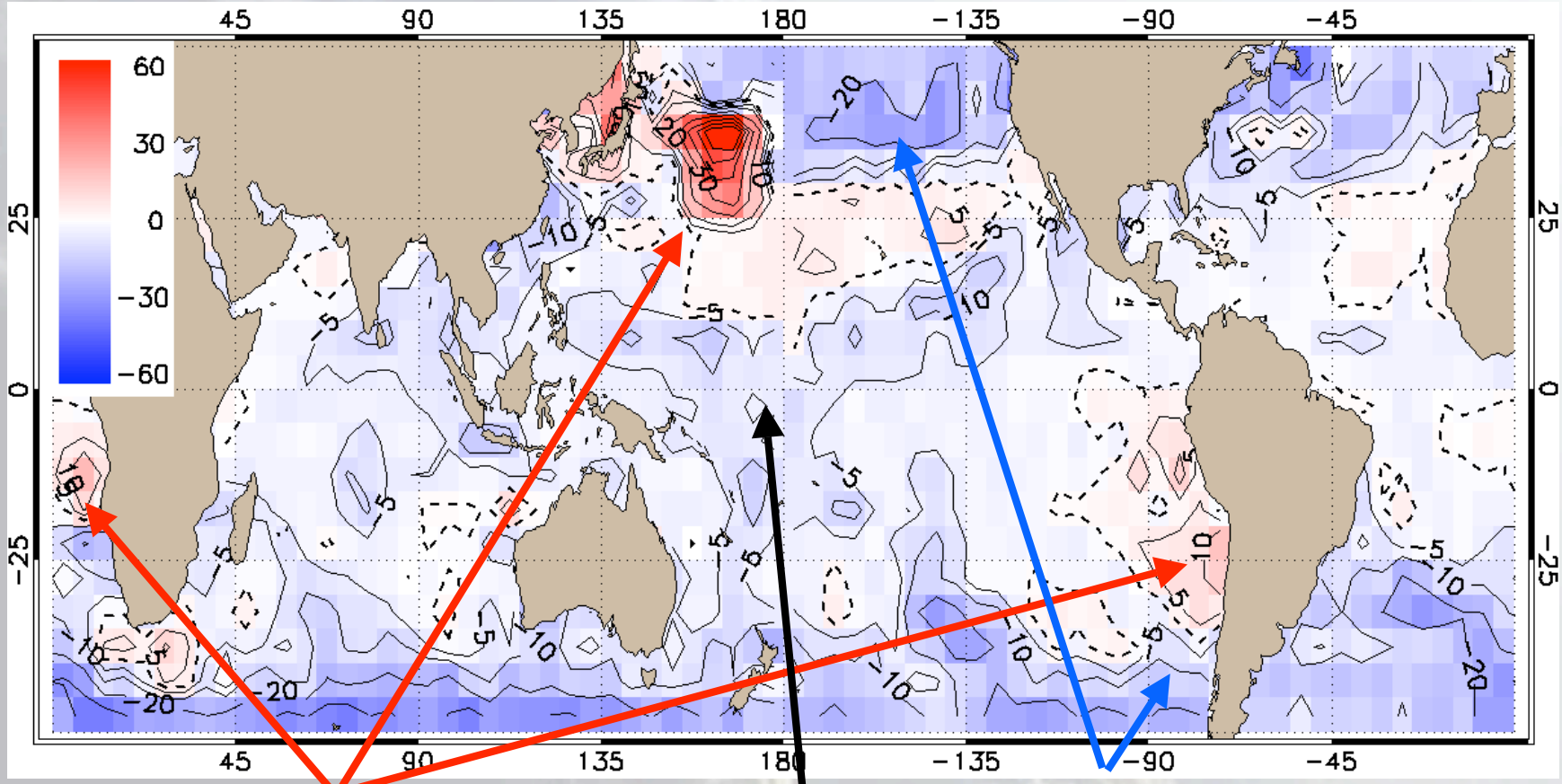
AIRS-AMSR-E comparison: Percent Differences in Water Vapor Climatologies

AIRS can be drier OR wetter than AMSR-E *because of cloud-induced sampling effects*

25 Dec 2002 to 15 Jan 2003



AIRS climatology is *wetter* than AMSR-E in stratus regions

Small difference in tropics

AIRS climatology is *drier* than AMSR-E at high latitudes

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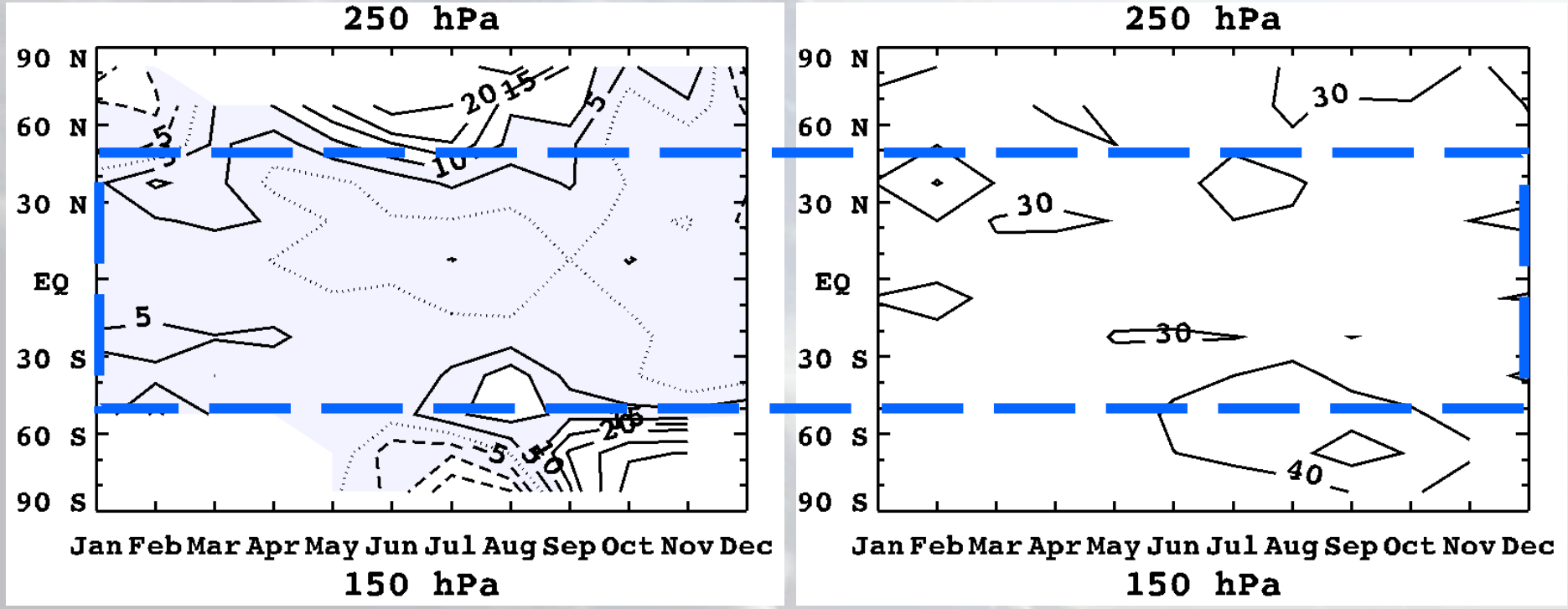
Comparisons of AIRS and MLS at 250 hPa

Bias ~±5%, RMS diffs ~30%, ±45° lats.

Twelve months in 2005, twelve zonal bands.



Biases: ±10% values shaded.

RMS of differences

From: Fetzer et al., (2007), Global comparisons of upper tropospheric water vapor observations from the Microwave Limb Sounder and Atmospheric Infrared Sounder satellite instruments, *JGR*, in preparation.

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Next Step:
Deliver a Merged Data Set for 2005

- ***Temperature***. **Surface to middle stratosphere temperature from AIRS.**
- ***Water vapor***. **TPW over oceans from AMSR-E; surface to upper troposphere water vapor from AIRS; upper troposphere and stratosphere water vapor from MLS.**
- ***Total cloud liquid*** **water over oceans from AMSR-E.**
- ***Cloud liquid water path*** **from MODIS.**
- ***Cloud ice water content*** **in the upper troposphere from MLS (215, 147 and 100 hPa)**
- ***Cloud cloud liquid water and ice*** **from CloudSat**

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Two Simple Short-term Science Goals

- **Close the atmospheric water cycle (Adam Schlosser MIT)**
- **Close the atmospheric energy cycle (Bing Lin, NASA Langley)**

The A-Train data are our best hope for accomplishing this.

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